Lesson 3

CYLINDER SERVICING, DISC AND PIN TYPE

Contents

What Do Keys Do?

They operate lock cylinders. Some people believe that a key is a magic wand that operates a cylinder and opens a lock. This, of course, is not true. How the inside of a cylinder is modified determines which keys operate it. The cuts of the key are not the main factor. If the cylinder has not been modified to accept a certain key, that key will not operate the cylinder. This is true even if the key is a master key.

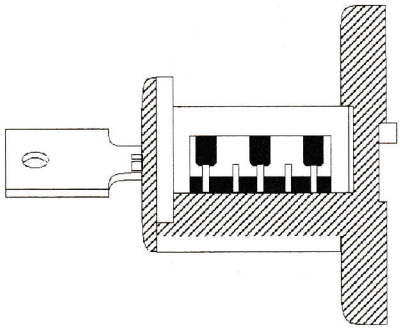
But before we begin to learn about that, let's review what you learned in Lesson 2, Key Blank Identification.

You learned a lot about keys in Lesson 2. You can identify the four types in use today. What are they? Yes, they are the bit, barrel, flat, and cylinder. You can tell from the title of this lesson that now we are going to focus on the types of locks that accept cylinder keys.

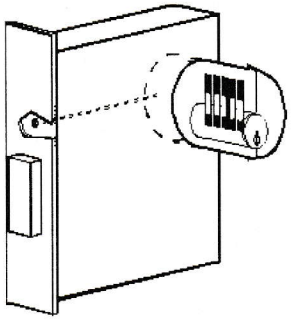
You also know how to match key blanks to customer keys. And you know how to use a key blank directory to make that process fast and accurate. You can identify the parts of a cylinder key, which will be a big help in this lesson as you learn about pin and disc type cylinders.

You know the purpose of keys is to operate locks. In this lesson, you'll learn about the part of the lock that keys operate: the cylinder. Cylinders come in many shapes and sizes. But they all serve the same purpose. A cylinder lets only certain keys operate the lock. So it also keeps other keys from operating the lock.

In this lesson, we'll focus on disc tumbler cylinders and pin tumbler cylinders. The keys that operate disc and pin tumbler cylinders are very similar. However, as you can see from the drawings below, the locks themselves are very different. And one uses discs while the other uses pins. When locksmiths talk about cylinders, they often use "tumblers" to mean discs or pins.



Disc Tumbler Cylinder



Pin Tumbler Cylinder

You'll notice that there's a lot more to learn in this lesson about pin tumbler cylinders than disc types. When locksmiths service a cylinder, it usually is a pin tumbler cylinder. So you need to know more about those. You'll also learn about Schlage Wafer Locks in this lesson.

Objectives

When you have completed this lesson, you should be able to

- ☞ Recognize the definitions of various lock cylinder terms.
- ☞ Identify the parts of a disc tumbler cylinder.
- ☞ Describe the functions of disc tumbler cylinder parts.
- ☞ List three common causes of disc tumbler cylinder malfunction and describe the symptoms and remedies for each.
- ☞ Identify the parts of a pin tumbler cylinder.
- ☞ Describe the functions of pin tumbler cylinder parts.
- ☞ List five common causes of pin tumbler cylinder malfunction and describe the symptoms and remedies for each.
- ☞ Identify the three types of wafers used in Schlage Wafer locks.

Main Ideas

1. Disc Tumbler Cylinders
2. Pin Tumbler Cylinders
3. Schlage Wafer Locks

Disc Tumbler Cylinders

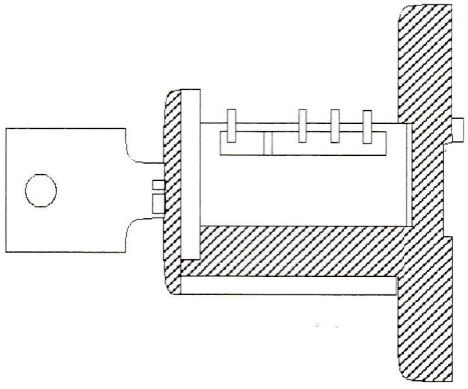
Locks that use disc tumblers are widely used today. They are most often used for office equipment, automobiles, and padlocks. They are popular for two main reasons:

1. They offer a higher level of security than bit and barrel key locks.
2. They cost less than pin tumbler locks.

In fact, disc tumbler locks are so inexpensive that, in most cases, it is less costly to replace disc tumbler locks than to repair or rekey them.

Design

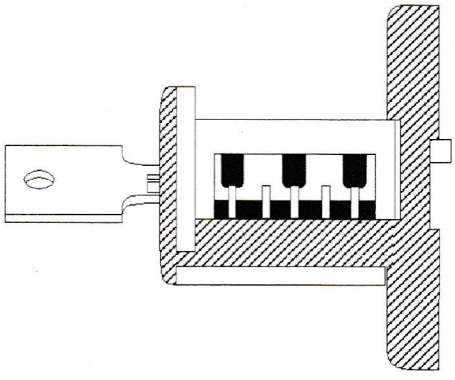
A disc tumbler cylinder generally holds five or six disc tumblers and springs. These tumblers and springs fit into channels in the cylinder. When the cylinder is in the locked position or the wrong key is inserted, one or more disc tumblers keep the key from turning.



Cylinder in locked position

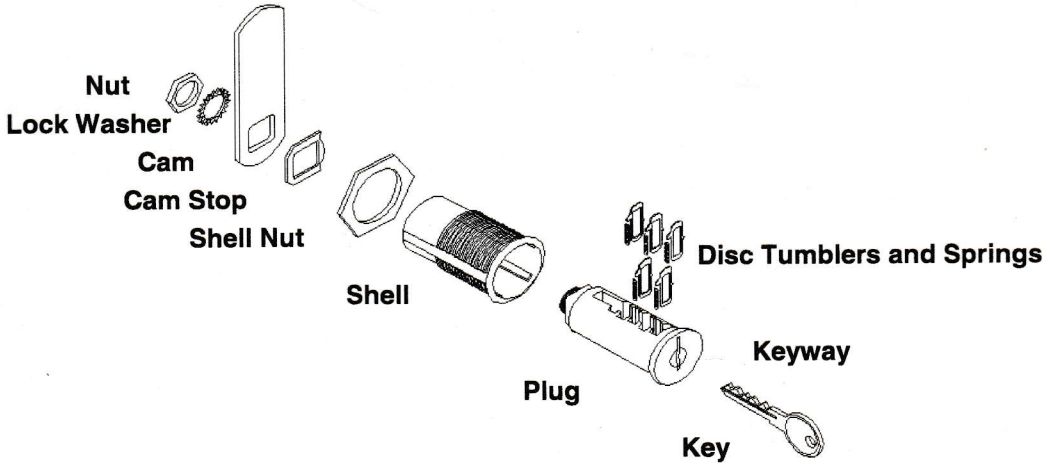
Shear Line—The space between the housing and plug of a cylinder

When the correct key is inserted, all five of the disc tumblers line up with the cylinder plug. This creates a **shear line**, which lets the key turn.



Cylinder in unlocked position

The Parts of the Disc Tumbler Cylinder



The ***shell nut*** holds the lock onto the door or drawer.

The ***shell*** or ***housing*** holds all the other cylinder parts.

The ***plug*** turns when the correct key is inserted.

The ***nut*** and ***lock washer*** hold the plug in the shell.

The ***keyway*** is the opening in the front of the plug. It is shaped to accept the key.

The ***disc tumblers*** block the shear line when locked and lift up to the shear line when the proper key is inserted.

The ***springs*** push the disc tumblers into the locked position.

The ***cam*** rotates when the key is turned, locking and unlocking the lock.

The ***cam stop*** allows the cylinder to stop turning at a specific point.

Keying the Disc Tumbler Cylinder

Keying—Arranging the discs or pins in a disc or pin tumbler cylinder to accept a specific key; reassembling a cylinder to accept a specific key

Standard Keying

The steps of the standard **keying** procedure for most disc tumbler cylinders are listed below.

1. Disassemble the cam lock and remove the plug from the shell.
2. Remove each of the discs from the cylinder.
3. Remove the springs.
4. Place a spring into the first slot.
5. Slide the correct disc tumbler back into the channel it came from.
6. Place a spring in the next spring slot, and so forth, repeating steps 4 and 5 for the rest of the chambers.
7. Insert the key into the plug, make sure it turns, and reassemble the cam lock.

Now, let's describe each step in more detail.

1. Disassemble the cam lock and remove the plug from the shell.

   Most disc tumbler plugs can be easily removed from the cylinder housing. Remove the nut or screw on the back of the lock, and then remove the plug from the front of the cylinder. However, it's not always that easy. We'll discuss the more difficult types in Lesson 11.

2. Remove each of the discs from the cylinder.

   Using tweezers, start from the front of the cylinder. Place each disc on your bench. Be sure to keep them in the order in which you remove them.

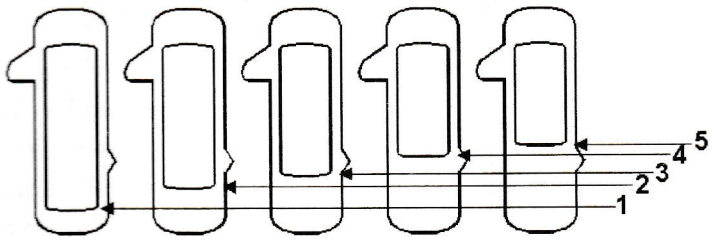
   Sometimes the discs have been held in place by a tiny fragment of metal on the cylinder plug. If this is the case, turn the cylinder upside down and gently tap the discs from the bottom. Use a small screwdriver or punch. Tap them out until you can remove them with tweezers.

Be gentle! If you tap a disc too hard, you will bend it!

Once the discs are in front of you, arrange them so that they are all in the same position. They look similar, don't they? They're not! The locations of the cutouts in the discs are different.

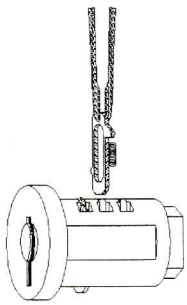
There are generally five sizes of disc tumblers. Each size has a different dimension from the bottom of the disc to the bottom of the cutout. The larger this dimension, the deeper the **key cut**. For the correct key to turn, the discs must line up with the shear line when we insert the key. If the cut of the key and disc do not match, the disc will keep the key from turning.

Key Cut—The cut made into the blade of a key to position the discs or pins in a disc or pin tumbler cylinder



3. Remove the springs.

   Notice the slots in the plug. There is one for each spring. Remove all of the springs. Since they are all the same size, don't worry about separating them or keeping them in order. Just make sure that you have one for each disc.



4. Insert a spring into the first slot. Repeat this step until all the slots contain a spring.

We will key this cylinder to the original key that operated it.

5. Slide each disc tumbler back into the channel it came from. Repeat this step until all the discs are returned to their channels. If the discs were staked in, it may be necessary to tap the disc gently back into place.

6. Insert the key into the plug and make sure it turns. If everything is correct, all the disc tumblers will line up with the perimeter of the cylinder plug. Reassemble the cam lock.

Master Keying—Arranging the discs or pins in a disc or pin tumbler cylinder to accept specific keys; reassembling a cylinder to accept specific keys

Key Section—The shape of a key blade as viewed from the bow toward the tip

Master Key—A key that operates all of the locks in a series

Change Key—A key that usually operates only one lock in a series

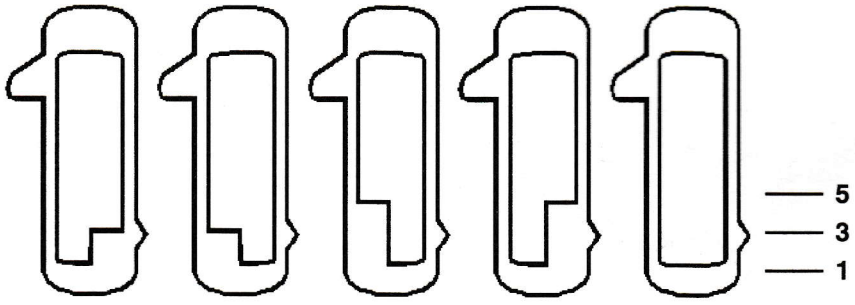
Master Keying

Most locksmiths rarely master key disc tumbler locks for two main reasons.

1. Disc tumbler cylinders operated by a master key usually require modifications by the lock manufacturer.
2. The cost of these locks are typically inexpensive compared to the of cost master keying. In other words, it's less costly to buy another lock.

However, some disc tumbler locks are designed for master keying. Since you may be required to master key one, you need to be able to recognize such a cylinder. Here's how.

The bottom of the cutout on disc tumblers designed for master keying has two levels. One level is for the change key and one level is for the master key. The **key section** on the **master key** blank is opposite the key section on the **change key**. Each key works one of the levels on the bottom of the cutout on the disc tumblers.



Service/Pin Kits

Almost all companies that manufacture disc tumbler locks provide service kits. These normally include keyway guides, disc tumblers, springs, keys, washers, nuts, and clips.

Common Service Malfunctions

Disc tumbler cylinders do not have many parts. So they do not malfunction very often. However, three common causes of disc tumbler cylinder malfunction are

- heavy usage,
- debris gets in the keyway of the lock, and
- bent disc tumbler.

Cause	Symptom	Remedy
Heavy Usage	The cylinder tumbler sticks and/or the key pulls out in any direction (the lock will not lock).	Replace the cylinder and/or the key.
Debris in the Keyway	Since the channels that hold the discs are so narrow, the smallest piece of debris can keep the disc from moving. The disc then keeps the barrel from turning.	Spray the lock with a good lubricant. Then run a lock pick or cut key in and out of the cylinder. This approach works most of the time.
Bent Disc Tumbler Common causes are • inserting the wrong key in the keyway and forcing it, • inserting the correct key in the keyway and forcing it too far, and • inserting a piece of metal into the lock to remove debris.	The correct key will not enter all the way into the cylinder. The correct key will not turn the cylinder.	Disassemble the lock and replace the disc tumblers. It may be less costly to simply replace the lock.

Just for Fun!

Count the number of disc tumbler locks in your home. Look at the locks on any office equipment, cabinets, padlocks, automobiles. I'll bet there are more than you thought. Make sure these locks are not protecting anything that is vitally important to you.

Now You Do It!

Keying a Disc Tumbler Cylinder

Envelope 3-1 contains a Cam Lock (combinated) and keys. Place these items on your workbench or table.

Follow the procedures on pages 3-6 and 3-7 of this lesson to

1. Disassemble the cam lock and remove the plug from the shell and
2. Disassemble the disc tumblers and springs from the plug.

To key the cylinder, complete the steps listed below. Refer to pages 3-6 and 3-7, as needed.

1. Separate the springs and disc tumblers. Place the disc tumblers in front of you in a straight line so you can visually compare them.
2. Place a spring in the first spring slot.
3. Locate a disc tumbler that lines up with the shear line when the key is inserted. Refer to the procedures on pages 3-6 and 3-7, as needed.
4. Place a spring in the next spring slot, and so forth, repeating steps 2 and 3 for the rest of the chambers.
5. Insert the key into the plug, make sure it turns, and reassemble the cam lock. Refer to the illustration on page 3-5, as needed.

You have now completed an important step in understanding cylinder servicing.

Organize the Main Ideas

This outline will help you organize the information in this section of the lesson. Read through the outline and jot down what you remember about each of the topics listed. If you can't remember details related to one or more of the topics, you may wish to reread the text before you go on.

1. Disc Tumbler Cylinders

   a. Design

   b. The Parts of the Disc Tumbler Cylinder

   c. Keying the Disc Tumbler Cylinder

      1) Standard Keying

      2) Master Keying

      3) Service/Pin Kits

   d. Common Service Malfunctions

      1) Heavy Usage

      2) Debris in the Keyway

      3) Bent Disc Tumbler

Check Your Knowledge 1

This quiz will help you check what you've learned in this section of the lesson. Read through the questions and jot down your answers. Then check those against the suggested answers at the end of this lesson. If your answers differ greatly from the suggested answers, you may wish to reread the text before you go on.

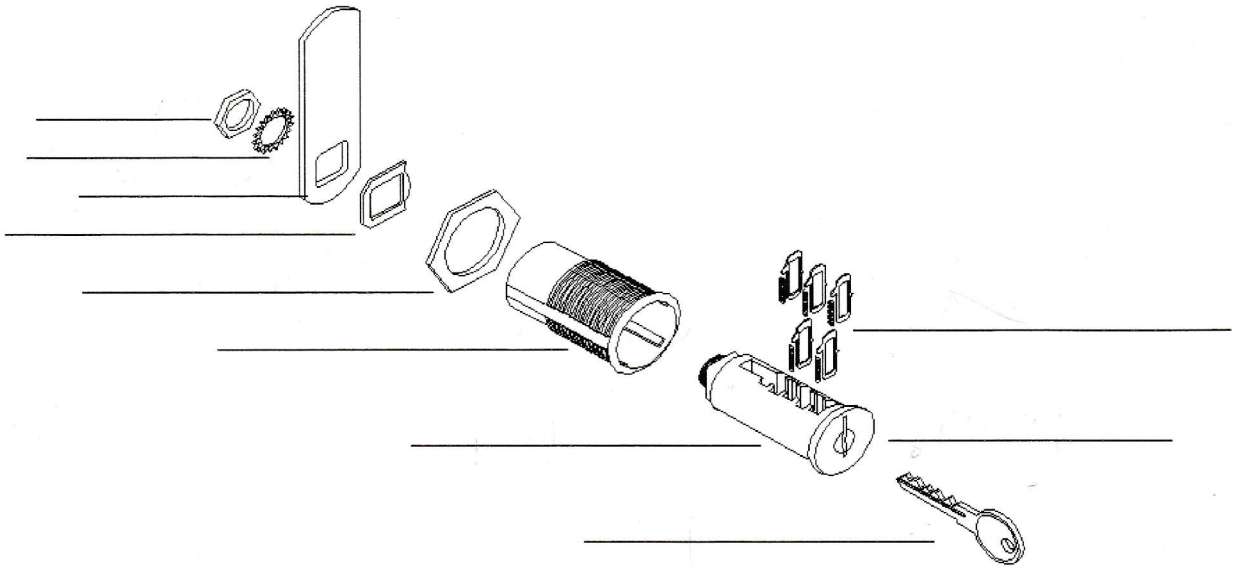
1. Disc tumbler cylinders are more secure than bit and barrel key locks. (True or False?)

2. The space between the housing and plug of a cylinder is called a _____ _____. (Fill in the blanks.)

3. Keying means arranging the discs or pins in a disc or pin tumbler cylinder to accept a specific key. (True or False?)

4. A master key is a key that usually unlocks only one lock in a series. (True or False?)

5. On the drawing below, please label the parts of the disc tumbler cylinder.



6. The _____ _____ block the shear line when locked and lift up to the shear line when the proper key is inserted. (Fill in the blanks.)

7. The springs push the disc tumbler into the locked position. (True or False?)

8. The cam stop allows the cylinder to stop turning at a specific point. (True or False?)

9. Put the steps for keying a disc tumbler cylinder in the correct order by placing the correct step number on the blank line in front of each direction.

_____ Insert the key into the plug, make sure that it turns, and reassemble the cam lock.

_____ Disassemble the disc tumblers and springs from the plug.

_____ Separate the springs and disc tumblers and place the disc tumblers in a straight line so you can visually compare them.

_____ Disassemble the cam lock and remove the plug from the shell.

_____ Locate a disc tumbler that lines up to the shear line when the key is inserted.

_____ Place a spring in the first spring chamber.

_____ Repeat steps 4 and 5 for the rest of the chambers.

10. List the three common causes of disc tumbler cylinder malfunction and describe the symptoms and remedies for each.

Pin Tumbler Cylinders

After centuries of large and bulky locks and keys, Linus Yale invented the pin tumbler cylinder. Pin tumbler cylinders had many advantages over the locks of the day, including

- more security,
- the use of smaller keys,
- easy adaptability to many types of locks, and
- capability of using thousands of different keys.

Over 150 years later, pin tumbler cylinders are still the most popular cylinders used. Pin tumbler cylinder keys are used on almost every type of lock manufactured today. However, they are mainly used for door locks.

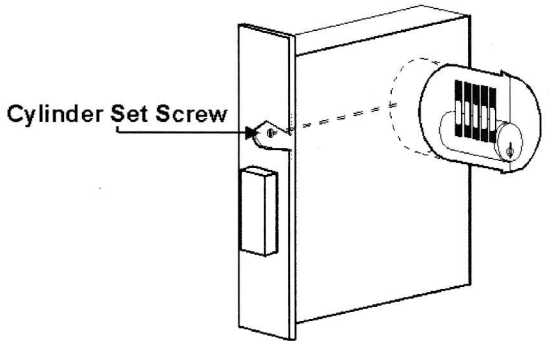
Design

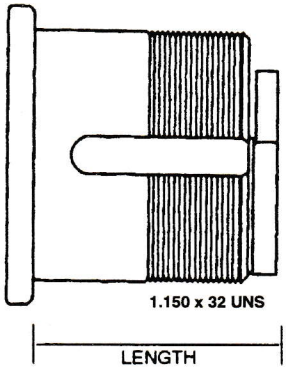
Many different styles and shapes of pin tumbler cylinders are used, but the most widely used are mortise, rim, and key-in-knob. They usually are used only for door locks.

Mortise Cylinders

Mortise Lock—A lock that is installed into a hole in the edge of a door

These cylinders are threaded into a **mortise lock** and secured in place by a set screw.





(courtesy of Ilco Unican)

Most mortise cylinders have the same diameter and thread size. The length of a mortise cylinder depends on the width of the door or the outside lock trim. When measuring a mortise cylinder, measure from the back side of the face to the end of the cam, as shown to the left.

A mortise cylinder will thread into almost any mortise lock. However, the cylinder will not operate the lock properly unless it has the correct cam on the back. When the key is turned, the cam rotates and engages the locking mechanisms. So if you use one manufacturer's cylinder and another's lock body, you must make sure that you have the correct cam on the cylinder.

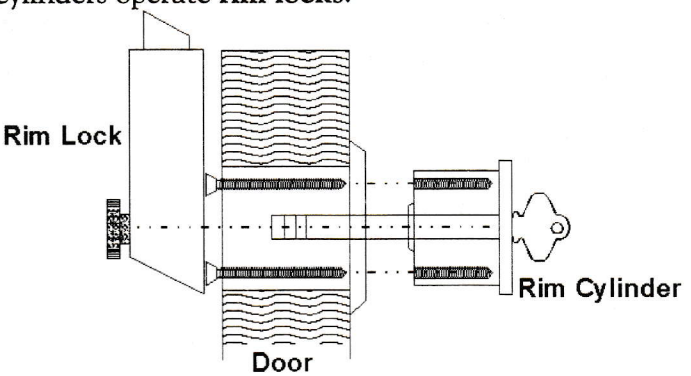
Rim Cylinders

These cylinders have the same basic design as mortise cylinders, except

- they are not threaded,
- they are secured to the door by two mounting screws and a mounting plate, and
- they do not use a cam.

Rim Lock—A lock that is installed onto the surface of a door

Rim cylinders operate **rim locks.**

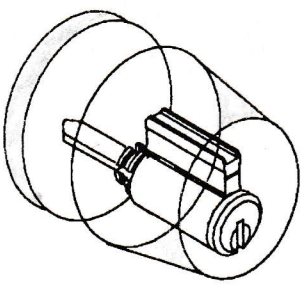


The mounting screws extend from inside the door through the mounting plate where they fasten into the back of the cylinder.

Instead of a cam, a rim cylinder uses a long tailpiece. This tailpiece extends from the back of the cylinder through the door where it engages the lock.

Key-in-Knob Cylinders

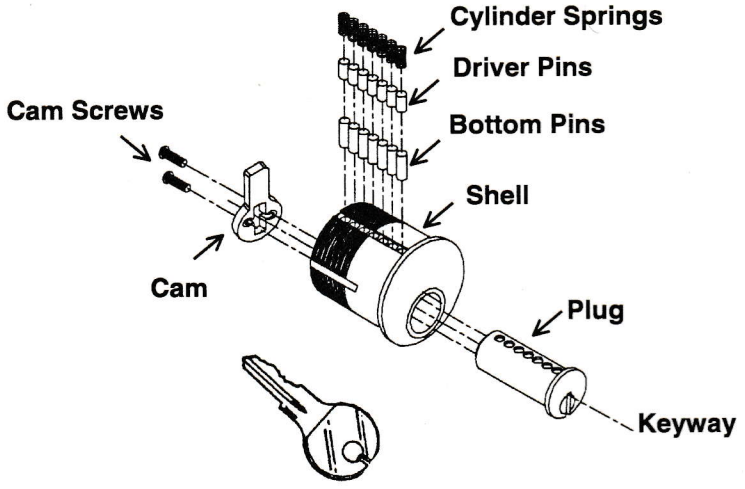
The name for these cylinders comes from the fact that the cylinders are located directly inside the lock knob. The inside mechanisms of knob locks differ from manufacturer to manufacturer. So the cylinders vary in shape and size. This means you cannot use a knob cylinder with any knob lock except the one it is designed for.



(courtesy of Ilco Unican)

The Parts of the Pin Tumbler Cylinder

Although mortise, rim, and key-in-knob cylinders look differently on the outside, they all operate the same way. The main parts of a pin tumbler cylinder are shown below.



(courtesy of Ilco Unican)

The ***cylinder springs*** push the driver pins down.

The ***driver pins*** are pushed down into the plug and prevent the plug from turning.

The ***bottom pins*** are lifted up to the shear line by the key.

The ***plug*** turns when the correct key is inserted.

The ***housing*** or ***shell*** holds all the other cylinder parts.

The ***cam*** engages the locking mechanism.

The ***cam screws*** hold the cam in place.

The ***keyway*** is the opening in the front of the plug. It is shaped to accept the key.

For the pin cylinder to operate properly, the correct key must be inserted.

Key Cut Root—The bottom of a key cut

When the correct key is inserted, the bottom pins rest on the **key cut roots**. These lift the pins up to the shear line, letting them turn.

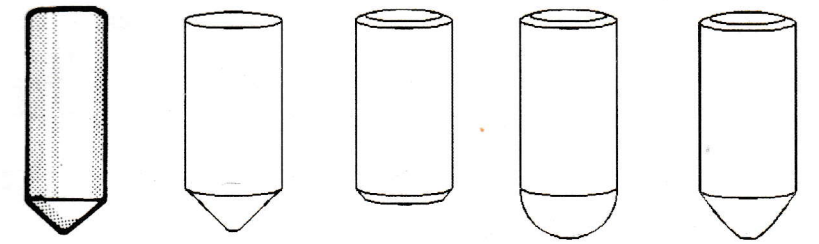
Pin Tumbler Cylinder Considerations

Factors you must consider when working with pin tumbler cylinders include

- special bottom pin shapes
- the length of the bottom pin
- the pin stack
- special driver (top) pin shapes
- original factory pins or LAB Universals 0.003

Special Bottom Pin Shapes

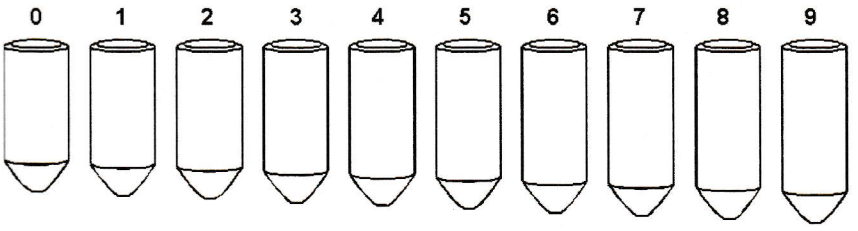
Most bottom pins have a pointed tip on the bottom and a flat surface on the top. This design forms the top of the pin to the shear line and lets the plug turn. Some manufacturers have special shapes on the bottom tip of the pin. These match the shape of the root of their key cuts. In these cases, it is very important to use the correct pins or LAB Universal tumbler pins.



LAB .003© Universal | **Schlage or Dexter** | **Kwikset** | **Weiser** | **Corbin Russwin**

The Length of the Bottom Pin

In a pin cylinder, the length of the bottom pin coincides with the depth of the key cut. A small bottom pin requires a shallow cut on the key. A large bottom pin requires a deep cut on the key. Lock manufacturers offer between 6 and 10 different lengths of bottom pins. The difference between each length size can be between 0.015" and 0.028". LAB Universal .003 bottom pin lengths start at 0.126" and end at 0.360" in steps of 0.003".



The Pin Stack

Pin Stack—The combined length of the bottom pin and the driver pin; the combined length of the bottom pin, the master pin, and the driver pin

The combined length of the bottom pin and the driver (top) pin is called the **pin stack**. When you key a cylinder, you must consider the pin stack.

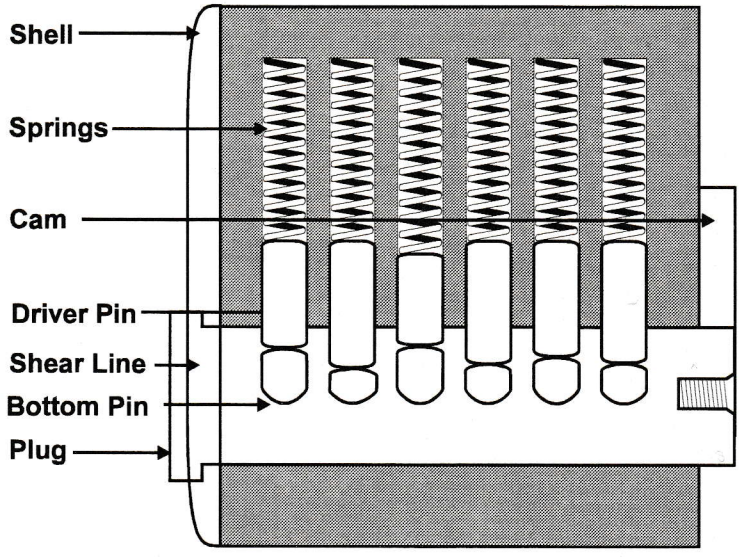
For a pin tumbler cylinder to operate correctly, the bottom pin and the top pin in each pin chamber must equate to a particular length. Here are some "rules" you must follow.

1. If you use a large bottom pin, you must use a small driver (top) pin.

   If you use a large bottom pin with a large top pin, the spring may be damaged by being forced into the top of the housing pin chamber when the key enters and exits the cylinder.

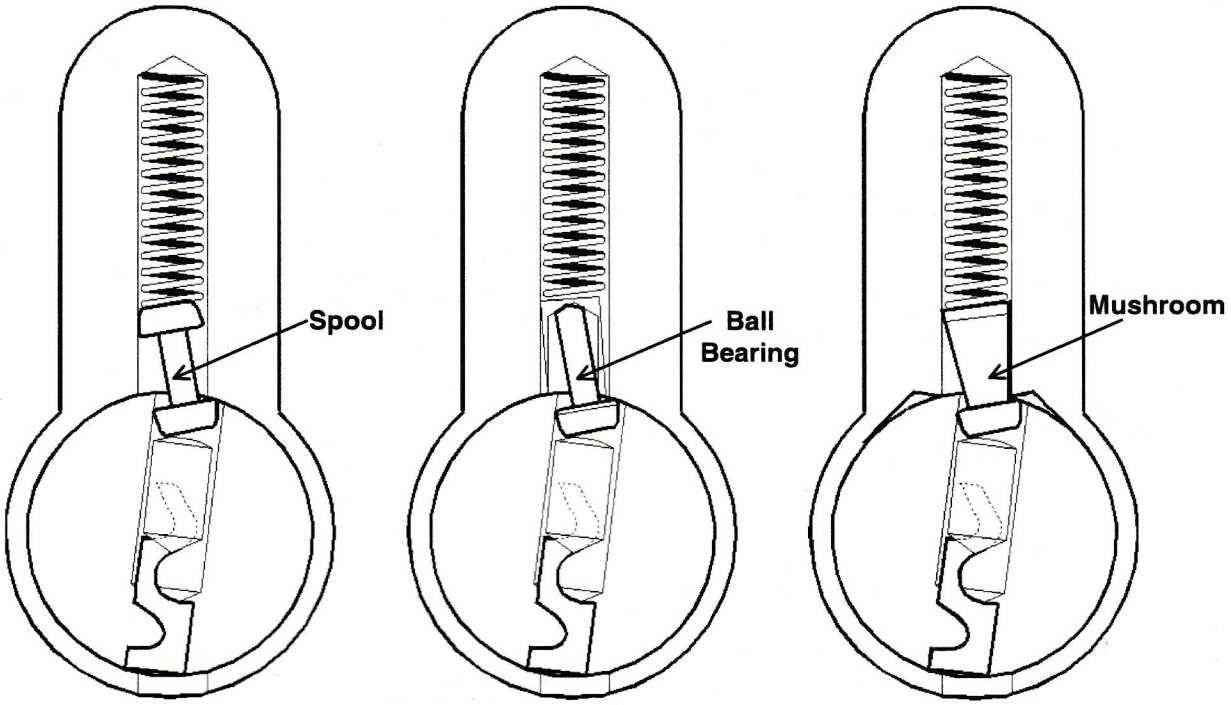
2. If you use a small bottom pin, you must use a large driver (top) pin.

   If you use a small bottom pin with a small top pin, the spring may not have enough tension to push the pins down into their proper locking position.



Special Driver (Top) Pin Shapes

Some lock manufacturers have tried to make their standard pin tumbler cylinders more secure. To do this, they change the shape of the driver (top) pins in their cylinders. Examples of these special shapes are shown below.



(courtesy of Dom)

These shapes make picking a lock more difficult. You'll learn more about this in Lesson 9, Professional Opening Techniques.

The First Pin Tumbler

The first locks were made of wood. Although they were probably invented in communities all over the world at about the same time, the first pin tumbler we know of was used in Egypt about 4,000 years ago. The lock was a wooden bolt that went across the door. It was locked by moveable pins that dropped into openings in the bolt. The pins stayed in the bolt because of gravity. A person unlocking the door would lift pegs that raised the pins enough to clear the door. Then the bolt could be pulled back and the door opened.

Pin Tumbler Cylinder Settings

When working on a pin tumbler cylinder, you will find the pin tumbler cylinder in one of three conditions. These conditions are called "settings." They are listed and described below.

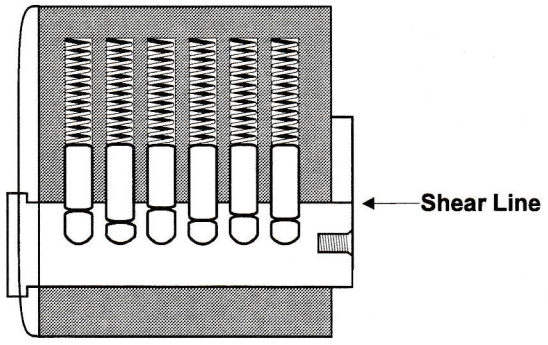
No Key in Cylinder Setting

When there is no key in the keyway, the driver (top) pins are forced down into the plug. This blocks the shear line and prevents the plug from being turned.

Note: Poor quality tumbler pins that are

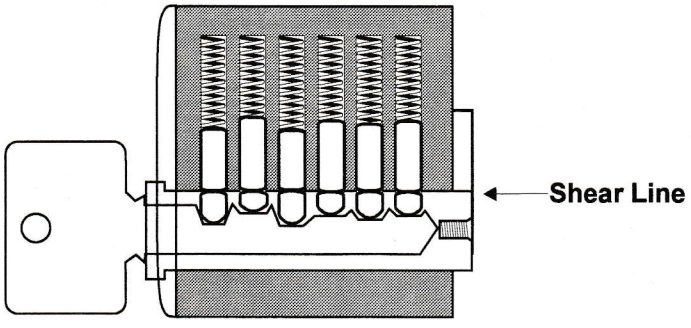
- **out of tolerance,**
- **cut off burrs, or**
- **our of round chamber**

will affect cylinder performance. The LAB Universal .003© pin is the closest tolerance pin manufactured.



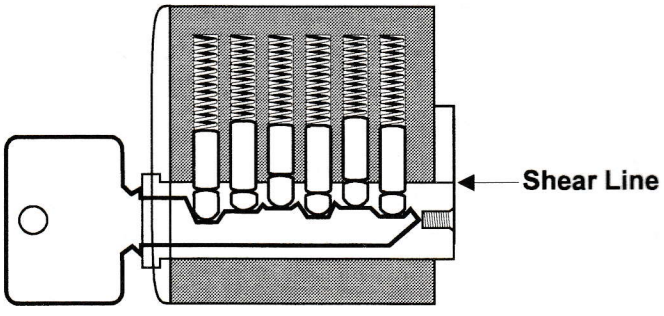
Correct Key in Cylinder Setting

When the correct key is in the keyway, all the bottom pins are at the shear line. This lets the plug turn.



Incorrect Key in Cylinder Setting

When an incorrect key is in the keyway, some of the bottom pins are above the shear line and some are below. This keeps the key from turning.



Keying the Pin Tumbler Cylinder

Although there are many different types of pin tumbler cylinders, all are keyed using the same procedures:

- disassembly,
- keying, and
- reassembly.

Standard Keying

The steps of the standard keying procedure for most pin tumbler cylinders are listed below. These apply to mortise, rim, and key-in-knob cylinders.

1. Remove the fasteners.
2. Turn the plug.
3. Remove the plug from the housing.
4. Select and insert the bottom pins.
5. Select and insert the driver (top) pins and cylinder springs.
6. Insert the plug into the housing.
7. Reinstall the cam or tailpiece with fasteners.
8. Remove the key.

Now, let's group these steps into disassembly, keying, reassembly and describe each in detail.

Disassembly Procedure

The steps for disassembling a pin tumbler cylinder are listed and described below.

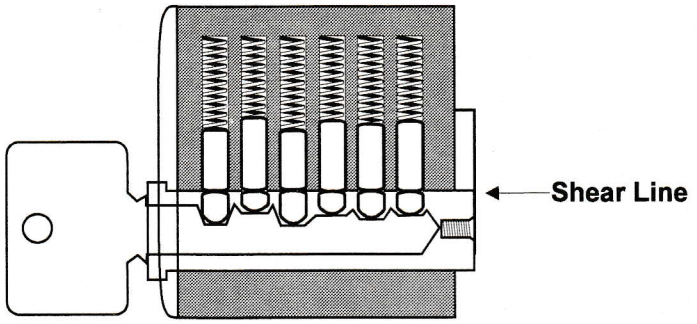
1. **Remove the Fasteners.**
   The fasteners (usually screws or a clip) are on the back of the cylinder. They hold the plug and housing together, and they hold the cam or tailpiece in place.

   When you remove the fasteners, make sure you are working over a clean flat work surface. If you drop a small part, you'll find it more easily. After removing the fasteners, put them and the cam or the tailpiece where you will not misplace them.

2. **Turn the Plug**
   Line up the bottom pins on the shear line and turn the plug slightly. The three most common ways to do this are
   - using the correct key,
   - shimming, and
   - picking and impressioning.

Using the Correct Key

This is the easiest method. Insert the correct key. The bottom pins line up to the shear line.



Shimming

When the correct key is not available, the next easiest method is to **shim** the lock open. The term "shim" describes both the method of opening the cylinder and the tool used to do it. A shim is a paper thin piece of metal inserted into the back of the cylinder along the shear line. Doing this separates the bottom pins from the driver (top) pins. Here's how.

Shim—A paper thin piece of metal inserted into the back of a cylinder along the shear line, thus separating the bottom pins from the driver pins and opening the lock

1. Place the shim gently into the back of the cylinder in between the plug and the shell.
2. Push gently until you feel the pin in the last chamber. This pin would be in the fifth chamber in a five-pin cylinder and the sixth chamber in a six-pin cylinder.
3. As soon as you feel the shim touching the last pin, pull it back slightly.
4. With the shim in place, insert a key blank all the way into the cylinder.
5. Very slowly pull the key blank out while pushing the shim gently toward the pin.

   As you pull the key out, the top of the bottom pin will move from the housing chamber to the plug chamber.

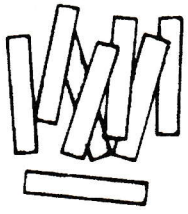
   The idea is to put gentle pressure on the pin with the shim and feel for the separation of the bottom pin and the driver at the shear line.

   As you use gentle pressure on the shim, it will slide between the driver pin and the bottom pin when they reach the shear line.

LAB

SHIMS

- **.0015 curved shims**
- **.302 stainless steel full hard**
- **Exceeds all industry specifications**
- **25 pack or 100 pack**

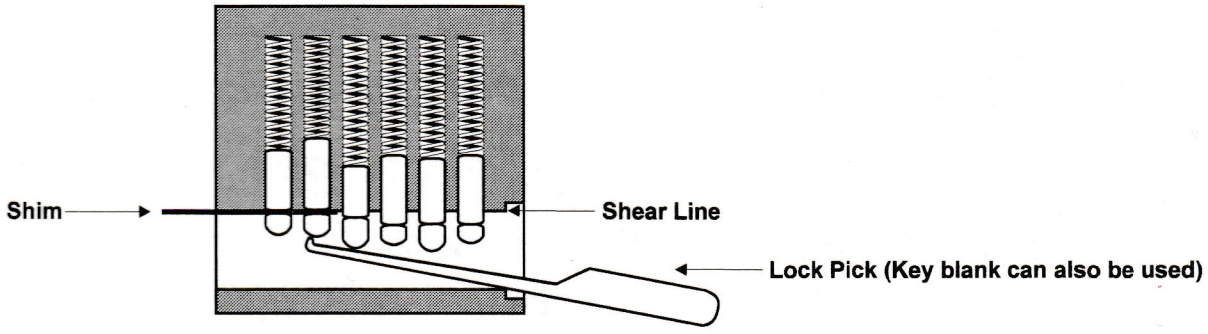


(courtesy of LAB)

6. Continue step 5 until you have separated all of the bottom pins from the driver (top) pins. Then the cylinder will open.
7. Rotate the plug slightly so that the driver pins will not enter into the bottom pin chambers.
8. Pull the shim and key blank out.

The most common reason for shimming to fail is the use of too much force.

Using too much force will bend the tip of the shim. Since there is not much room between the bottom pin and the driver (top) pin, any bend in the shim may keep it from easily sliding through the cylinder.



Picking and Impressioning

Picking the cylinder open will be addressed in Lesson 9. Impressioning the cylinder open will be covered in Lesson 10.

3. **Remove the Plug from the Housing**

When keying a pin tumbler cylinder, you must change the driver (top) pins, bottom pins, and cylinder springs. If you use the correct method, you can key the cylinder quickly and easily. If you use an incorrect method, the process will be time consuming and difficult. If you just pull the plug out of the cylinder, the driver pins and cylinder springs will fall out of the housing and you could lose them.

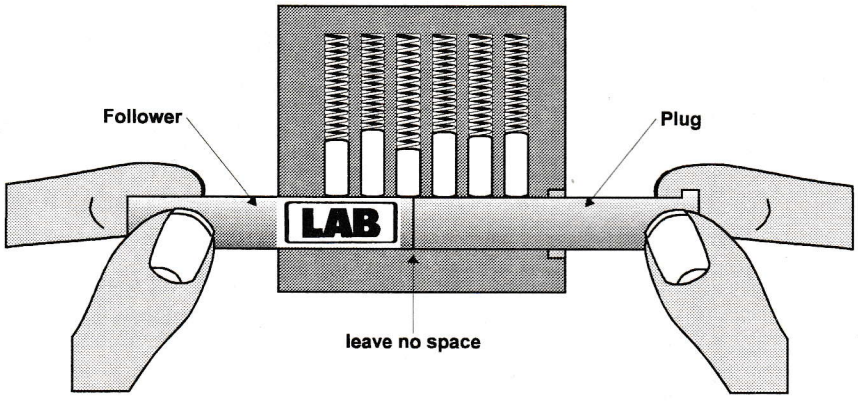
Because of the plug shoulder, you can remove the plug from the front of the cylinder only.

Follower—A piece of metal the exact diameter of the plug and used to remove the plug from the housing

Correct methods usually require correct tools. The tool for this process is a **follower**. The follower is a piece of metal the exact diameter of the plug. A quality follower is designed to fit on the end of the plug snugly so that there isn't any space between the plug and the follower. Use the follower to remove the plug. Here's how.

1. Fit the correct follower snugly over the end of the plug.
2. Slowly slide the follower toward the front of the cylinder. While doing this, make sure the follower and the plug do not separate. As you slide the follower toward the front of the cylinder, the plug will move out of the housing and the follower will end up in the same place as the plug once was.
3. Place the housing (with the follower inserted) on the bench.

Any space between the plug and the follower may cause a driver (top) pin to get stuck. If this happens, the follower will not enter the cylinder any farther. Move the pin blocking the follower back into place.



Keying Procedure

4. **Select and Insert the Bottom Pins.**

   Select the key that operates the cylinder. Place that key into the plug.

   Some locksmiths use a plug holder. However, it is not necessary to do so. Once you learn to rekey locks without a plug holder, you rarely will need to use one.

   In most cases, the key cuts are read from the bow of the key to the tip of the key. Let's walk through this.

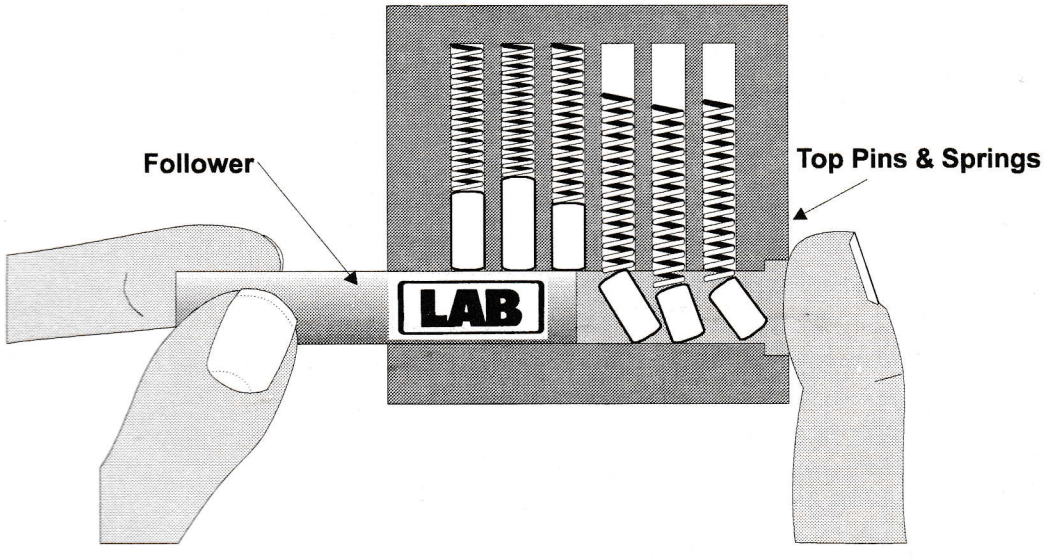
Combination—The group of numbers that represent the bitting of a key and/or the number of discs or pins in a disc or pin tumbler cylinder

Bitting—The numbers that represent the actual cuts or combination of the key

   Let's determine that the **combination** of the key is 614923, bow to tip. The combination tells you the **bitting** of the key and/or the number of pins in pin tumbler cylinders. First, remove all of the existing pins from the plug. Then using your tweezers, remove a number 6 bottom pin from the pin kit and place it into the first chamber. Look to make sure that the pin lines up to the top of the plug. Now do the same for each of the next five pins.

5. **Select and Insert Driver Pins and Cylinder Springs.**

   Hold the housing in one hand. With the other hand, slowly pull the follower back so that the first three chambers in the housing are exposed. The cylinder springs and driver (top) pins will pop out of the housing chambers.



Starting with the third chamber insert a new spring. From the pin kit, select the correct top pin for that chamber. Insert it into the housing chamber and hold it there with the tweezers. At the same time, move the follower against the pin, putting pressure on the pin to hold it in place.

Push the pin all the way into the housing chamber with the tweezers and slide the follower over the pin. This secures the top pin in the chamber.

Repeat this process with the second and the first chambers.

Turn the cylinder around and change the cylinder springs and driver (top) pins in the fourth, fifth, and sixth chambers.

Reassembly Procedure

6. **Insert the Plug into the Housing.**

   Place the plug with the key in it in one hand. Hold the housing with the follower in the other hand. Line them up and slide the plug back into the housing. Turn the key to make sure that the plug rotates.

Do not pull the key out yet!

If you pull the key out without first installing the fasteners on the back, the plug may pull out of the housing! Be careful!

7. **Reinstall the cam or tailpiece with the fasteners.**
8. **Remove the key.**

Master Keying

We will cover Basic Master Keying of pin tumbler cylinders in Lesson 6. For now, you need to know the effect master keying has on a pin tumbler cylinder. A cylinder that is master keyed is less secure than a cylinder that is not. To allow multiple keys to operate a pin cylinder, the locksmith adds master pins. And the more master pins that are added, the less secure the system is.

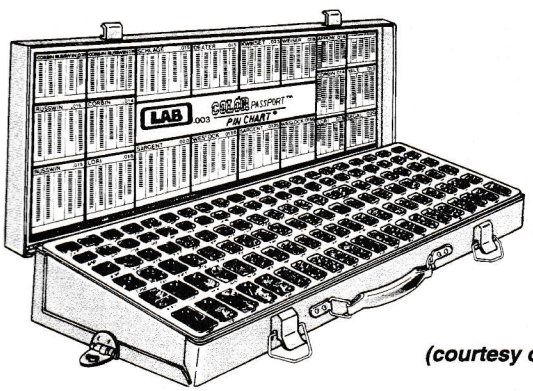
Service/Pin Kits

Most major lock manufacturers have service kits available to use when rekeying their pin cylinder locks. These kits contain

- depth gauges,
- bottom pins,
- driver (top) pins,
- master pins, and
- cylinder springs.

Normally these pin kits also include a chart indicating which pins to use.

LAB produces universal pin kits that can be used with most locks. These pin kits contain a huge assortment of pins. They include a chart stating which pins to use with each major manufacturer. These pin kits are commonly available with a difference between each pin of 0.005" or 0.003". The plus of such a kit is that you can use it for locks made by many manufacturers. They also are available in many different sizes, shapes, and materials, such as metal, wood, and polyethylene.



(courtesy of LAB)

LAB

Pro Wedge 5
EPK 005
.005 increments
102 Sizes
Top Pins: .010 - .300
Bottom Pins: .150 - .360

Pro Wedge 3
EPK 003
.003 increments
124 Sizes
Top Pins: .010 - .200
Bottom Pins: .156 - .360

Just for Fun!

See how many pin tumbler locks are in your home. Look at the locks on all the doors. Some locks have a cylinder on both sides of the door. Watch for these. Don't forget the office equipment, cabinets, padlocks, and automobiles. I'll bet there are more than you thought.

Common Service Malfunctions

The table below shows you the common causes for pin tumbler cylinder malfunction, their symptoms and remedies.

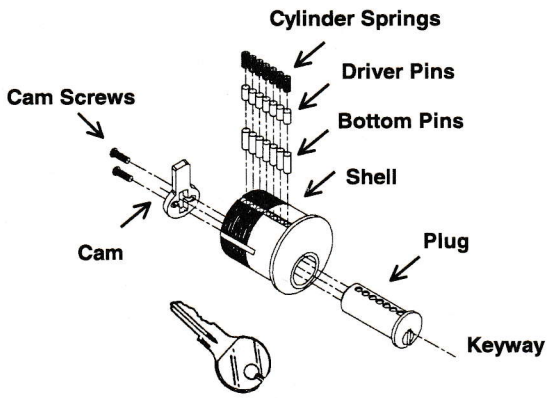
Cause	Symptom	Remedy
Heavy Usage	The cylinder sticks and/or the key pulls out in any direction.	Replace the cylinder and/or the key.
Debris in the Keyway	The pin chambers are only slightly larger than the pins. So the smallest piece of debris may cause the pins to stick. This may keep the pins from lining up on the shear line, keeping the plug from rotating.	Spray the lock with a good lubricant. Then run a lock pick or cut key in and out of the cylinder. If this doesn't work, disassemble the cylinder. Clean and lubricate it. Then insert new pins and cylinder springs and reassemble.
Using the Key as a Door Pull Folks have a tendency to pull the door open with the key after the lock has been unlocked.	The key is very loose when it is operating the cylinder. You must "jiggle" the key to turn the cylinder.	Pin tumbler cylinders need to be replaced more often on doors that open out. Check the plug to see if the chambers have become oblong from pulling. They should be round. If they are not round, replace them.
Loose Screws on the Back of the Cylinder	The key will not pull out of the cylinder. The key rotates the plug, but is difficult to pull out.	Remove the cylinder from the door, and tighten the screws.
Filed Plug Folks sometimes do this so that the plug rotates more smoothly. However, this is not the proper way to rekey a lock.	The master pin is stuck between the plug and the shell because the shear line has become too wide. Incorrect keys turn the cylinder because the shear line has become too wide.	If there is evidence that the cylinder plug has been filed, replace the plug.

Now You Do It!

Keying A Pin Tumbler Cylinder

Please empty the contents of the envelope marked 3-2 onto your work bench. The contents of the envelope are listed below. Please make sure all parts are there.

1. Mortise Cylinder (uncombinated)
   - Plug
   - Shell
   - Pin Cover
   - Cam
   - Cam Screws
2. Cylinder Springs
3. Driver Pins
4. Bottom Pins
5. Key
6. Follower Tool

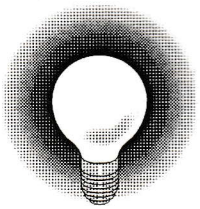


Follow this procedure to key the pin tumbler cylinder.

1. Remove the cam screws from the back of the cylinder. Place the screws and cam to the side.
2. Remove the plug from the shell.
3. Place a spring in each of the chambers in the shell, using tweezers.
4. Starting at the rear pin (chamber #5), place a top pin in and depress it. Take your follower and insert it from the rear to hold this tip pin in place. Repeat this step for chambers 4, 3, 2, and 1.
5. Insert the key into the plug and locate and place the correct bottom pin into each chamber. All pins should be flush with the top of the plug.
6. Insert the plug into the cylinder by pushing out the follower tool. Be sure to maintain contact between the plug end and the following tool at all times.
7. Rotate the key to make sure it turns freely. Hold the plug in while removing the key.
8. Reassemble the lock by installing the cam and cam screws.
9. Insert the key and make sure it works.

You have now completed an important step in understanding cylinder servicing.

Organize the Main Ideas



This outline will help you organize the information in this section of the lesson. Read through the outline and jot down what you remember about each of the topics listed. If you can't remember details related to one or more of the topics, you may wish to reread the text before you go on.

1. Pin Tumbler Cylinders
   a. Design
      1) Mortise Cylinders

      2) Rim Cylinders

      3) Key-in-Knob Cylinders

   b. The Parts of the Pin Tumbler Cylinder

   c. Pin Tumbler Cylinder Considerations
      1) Special Bottom Pin Shapes

      2) The Length of the Bottom Pin

      3) The Pin Stack

      4) Special Driver (Top) Pin Shapes

5) Pin Tumbler Cylinder Settings
   (i) No Key in Cylinder Setting

   (ii) Correct Key in Cylinder Setting

   (iii) Incorrect Key in Cylinder Setting

d. Keying the Pin Tumbler Cylinder
   1) Standard Keying
      (i) Disassembly Procedure

      (ii) Keying Procedure

      (iii) Reassembly Procedure

   2) Master Keying

   3) Service/Pin Kits

e. Common Service Malfunctions
   1) Heavy Usage

   2) Debris in the Keyway

   3) Using the Key as a Door Pull

   4) Loose Screws on the Back of the Cylinder

   5) Filed Plug

Check Your Knowledge 2

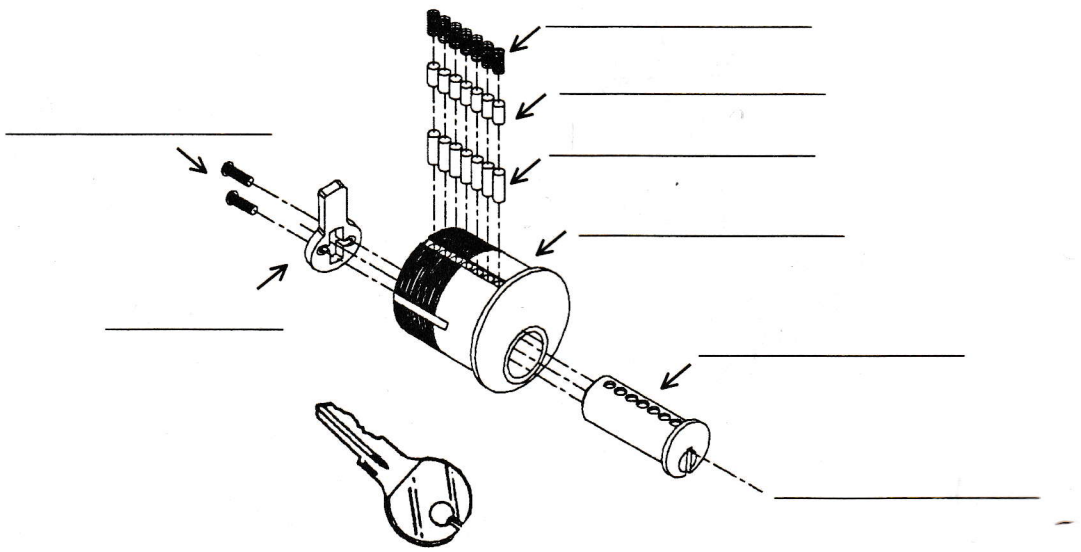
This quiz will help you check what you've learned in this section of the lesson. Read through the questions and jot down your answers. Then check those against the suggested answers at the end of this lesson. If your answers differ greatly from the suggested answers, you may wish to reread the text before you go on.

1. The most widely used pin tumbler cylinders are the _____, the _____ lock, and the _____. (Fill in the blanks.)

2. The bottom of a key cut is called the _____ _____ _____. (Fill in the blanks.)

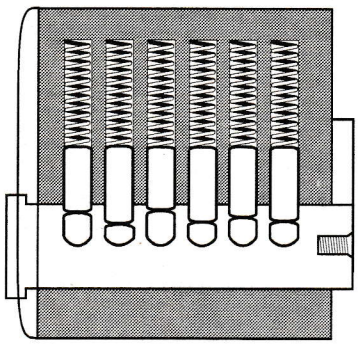
3. The pin stack is the combined length of the cylinder spring and the driver (top) pin. (True or False?)

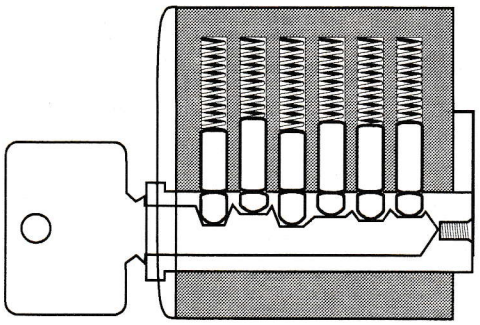
4. On the drawing below, please label the parts of the pin tumbler cylinder.

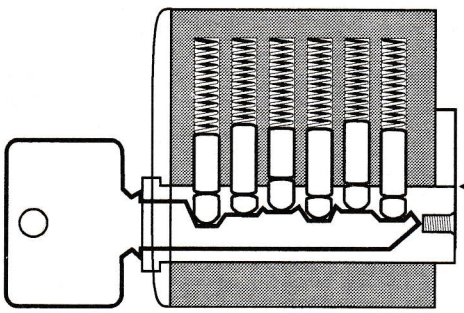


(courtesy of Ilco Unican)

5. Label each of the pin tumbler cylinder settings pictured below.







6. A piece of metal the exact diameter of the plug that is used to remove the plug from the housing is called a _____. (Fill in the blank.)

7. In a pin tumbler cylinder, the bottom pins are pushed down into the plug and prevent the plug from turning. (True or False?)

8. Put the steps for keying a pin tumbler cylinder in the correct order by placing the correct step number on the blank line in front of each direction.

_____ Turn the plug.
_____ Remove the fasteners.
_____ Remove the plug from the housing.
_____ Select and insert driver (top) pins and cylinder springs.
_____ Select and insert the bottom pins.
_____ Insert the plug into the housing.
_____ Remove the key.
_____ Reinstall the cam or tailpiece with fasteners.

9. Adding _____ _____ to master key a pin tumbler cylinder makes that cylinder less secure than a cylinder that is not master keyed. (Fill in the blanks.)

10. What are the two common problems caused by filing a plug?

Schlage Wafer Locks

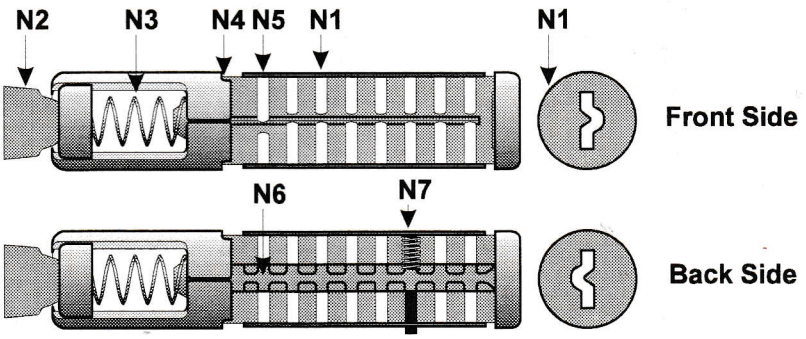
The Schlage wafer keyway unit was first marketed in 1927. It was designed to be much more secure and durable than a disc tumbler lock. In addition, it was much less costly than a pin tumbler lock.

Wafer locks are no longer manufactured. However, you will still find wafer locks in residences and small businesses. So you need a working knowledge of these locks.

Design

Schlage wafer locks work on the same basic idea as other locks. A tumbler blocks the plug from rotating until it is properly positioned by the correct key. However, the wafer lock uses eight wafer pins. These allow many more key combinations than disc tumbler locks.

And, as you can see in the illustration below, the design is very different.



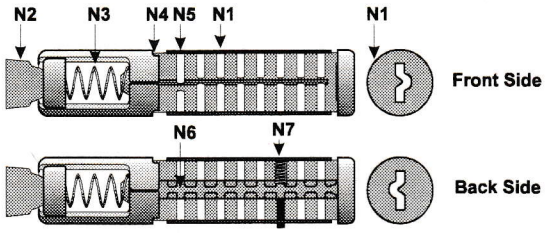
(courtesy of Schlage)

When working with the keyway unit, hold it in your left hand. Make sure the "V" grooved dividing strip (N1) is facing you. In this position, the spring comb is on the underneath side and cannot be seen.

The bulge at the extreme left is the keyway cam (N2). The most common form of this cam is the one illustrated above. To the right is the plunger spring (N3).

Next to this is the keyway frame (N4). This frame includes the entire steel area from the plunger spring to the finished cap of the keyway unit. This steel framework holds the wafers. The wafers are activated when the key is inserted.

The first column (N5) to the right of the plunger spring contains two slots. This is the location of the master wafer. Notice that the slots in this column are not the same size as the other slots in each row. In the remaining columns, the top slot is shorter than the bottom slot.



(courtesy of Schlage)

In some units, the relationship of these slots is reversed. In other words, the long slot is on top and the short is on the bottom.

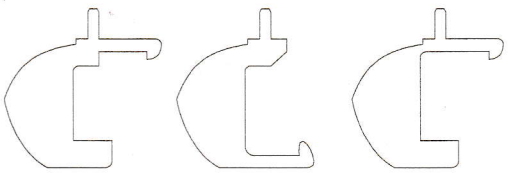
Notice the metal spring rack (N6) on the reverse side of the keyway unit. This rack looks like a comb. The springs (N7) are seated on this rack.

Wafers

The wafer lock uses three types of wafers:

1. The master wafer,
2. The combination wafer, and
3. The series wafer.

You must be able to recognize each type before you insert it in the keyway unit. An easy way to do that is to always arrange them so that the small bulge is upward and the opening is to the right.



(courtesy of Schlage)

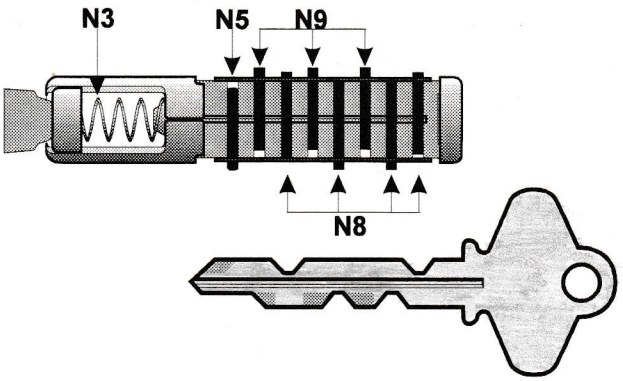
Notice that each of the three types has a definite outline. The master wafer has a notch cut out at the base of the bulge, just inside the spring seat.

The combination wafer has a bulge on the rounded shoulder, opposite the spring seat location.

The series wafer has the bulge at the top of the wafer, close to the spring seat. But it does not have the small notch, as does the master wafer.

Operation of the Keyway Unit

Here are two wafer keyway units set to the same combination. The unit below is in the relaxed position. The key is out of the keyway.



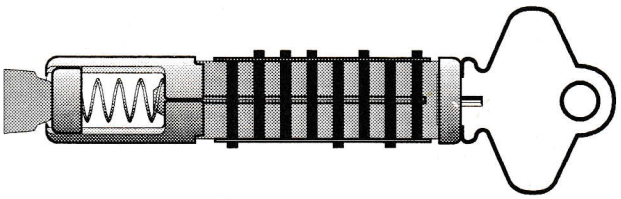
(courtesy of Schlage)

Look at the illustration above. Notice the four bulges of the wafers. You can see one at the bottom and three at the top. The first bulge to the right of the plunger spring (N3) is the master wafer (N5). This remains out except when it is pulled in by the uncut portion of the tip of the key. That part is shaded in the drawing. The cut portion of the tip allows full insertion of the key into the keyway.

The three bulges (N9) at the top of the keyway are series wafers. When the key is inserted, the uncut portion opposite the bulge (shaded) pulls the series wafers into the keyway.

The remaining four wafers (N8) in the keyway are combination wafers.

The unit below has the proper key inserted.

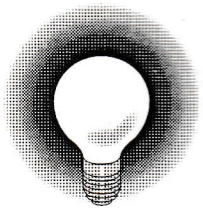


(courtesy of Schlage)

Both in the relaxed position and with the key inserted, these wafers lie within the keyway unit. Therefore, cuts on the key adjacent to their bulges are needed to keep them from being pushed out into the locking position

An improper key will not draw back all the bulges of the master and series wafer. And it will extend some or all of the bulges on the combination wafers.

Organize the Main Ideas



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1. Schlage Wafer Locks

   a. Design

      1) Wafers

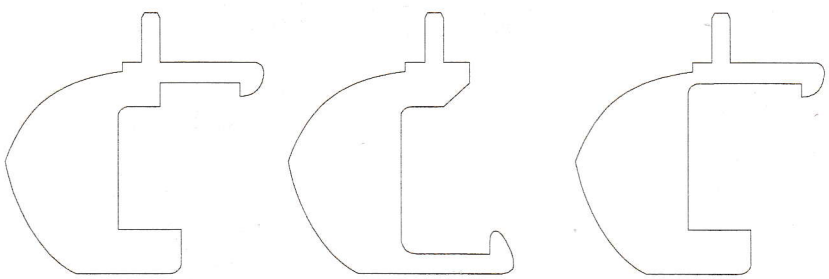
      2) Operation of the Keyway Unit

Check Your Knowledge 3

This quiz will help you check what you've learned in this section of the lesson. Read through the questions and jot down your answers. Then check those against the suggested answers at the end of this lesson. If your answers differ greatly from the suggested answers, you may wish to reread the text before you go on.

1. Schlage Wafer locks are more secure than disc tumbler locks. (True or False?)

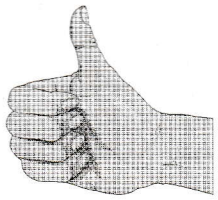
2. The drawing below shows the three types of wafers used in Schlage Wafer locks. Please label each with its correct name.



_____ _____ _____

(courtesy of Schlage)

Now You Can Do It!



You've reached the end of the lesson, but what have you learned? Let's find out. First complete the exercise below using only your memory. Next go back to the text to complete and/or check your answers.

1. Recognize the definitions of various lock cylinder terms. (Write the word or words defined on the blanks provided.)

   The space between the housing and plug of a cylinder is a _____.

   Arranging the discs or pins in a disc or pin tumbler cylinder to accept a specific **key** is called _____.

   The cut made into the blade of a key to position the discs or pins in a disc or pin tumbler cylinder is a _____.

   Arranging the discs or pins in a disc or pin tumbler cylinder to accept specific **keys** is called _____.

   The shape of a key blade as viewed from the bow toward the tip is the _____ _____.

   A key that operates all of the locks in a series is a _____.

   A key that usually operates only one lock in a series is a _____.

   A lock that is installed into a hole in the edge of a door is a _____.

   A lock that is installed onto the surface of a door is a _____.

   The combined length of the bottom pin and the driver (top) pin is the _____.

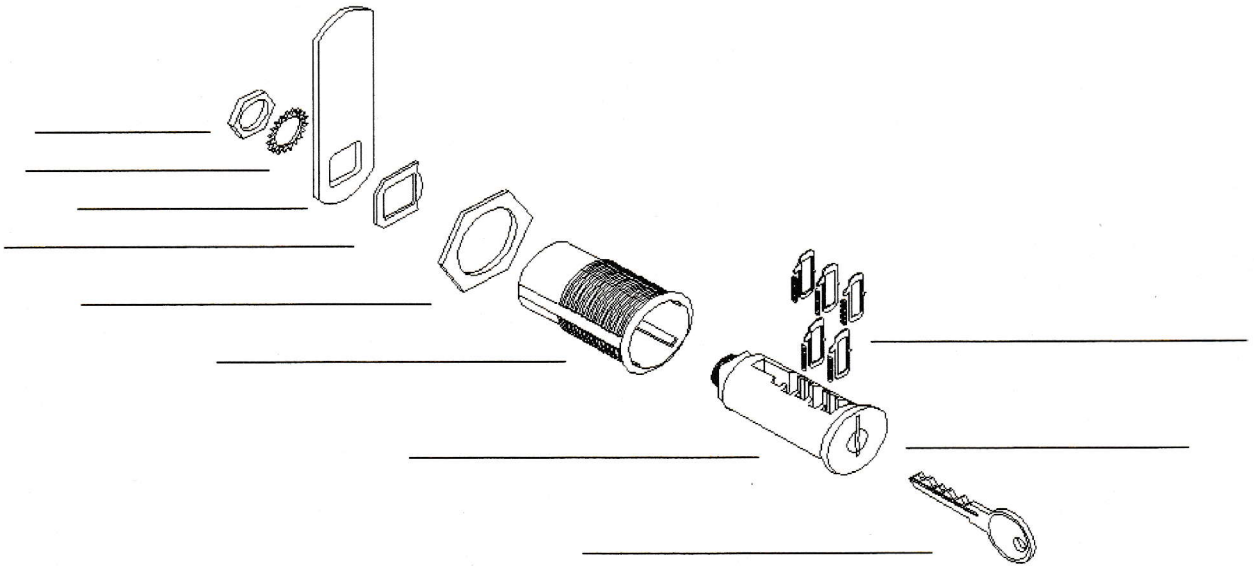
   A paper thin piece of metal inserted into the back of a cylinder along the shear line, thus separating the bottom pins from the driver (top) pins and opening the lock, is a _____.

   A piece of metal the exact diameter of the plug that is used to remove the plug from the housing is a _____.

   The group of numbers that represent the bitting of a key and/or the number of discs or pins in a disc or pin tumbler cylinder is the _____.

   The numbers that represent the actual cuts or combination of the key are called the _____.

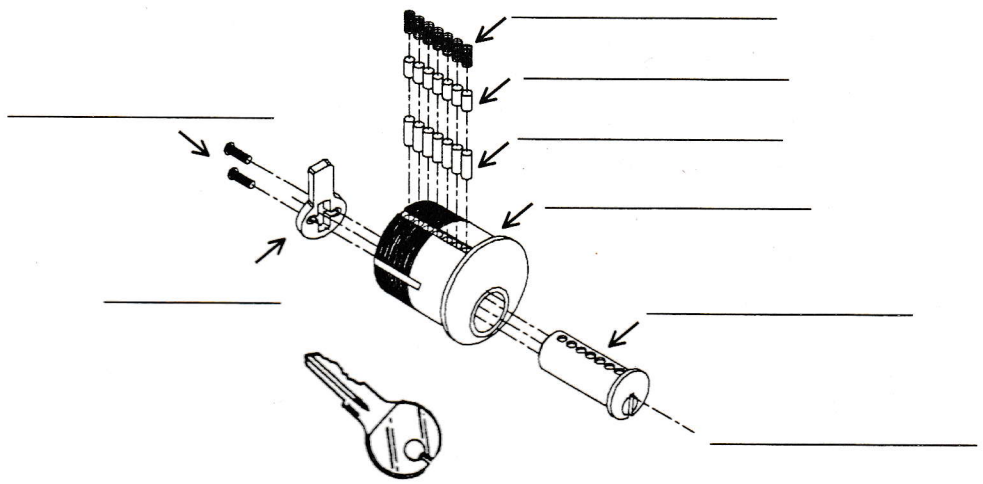
2. Identify the parts of a disc tumbler cylinder. (Label the drawing below.)



3. Describe the functions of disc tumbler cylinder parts (which you labeled in the above item).

4. List the three common causes of disc tumbler cylinder malfunction and describe the symptoms and remedies for each.

5. Identify the parts of a pin tumbler cylinder. (Label the drawing below.)

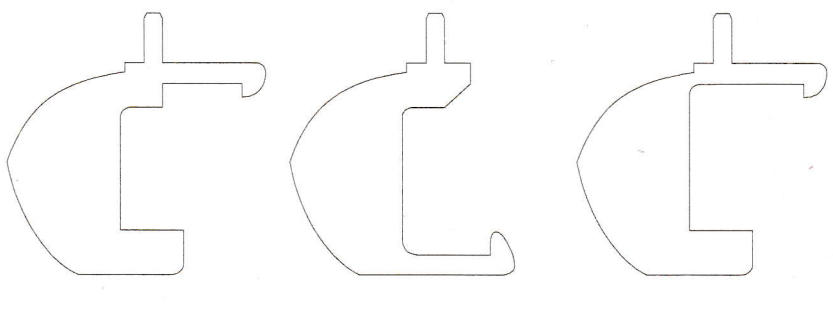


(courtesy of Ilco Unican)

6. Describe the functions of pin tumbler cylinder parts (which you labeled in the above item).

7. List the five common causes of pin tumbler cylinder malfunction and describe the symptoms and remedies for each.

8. Identify the three types of wafers used in Schlage Wafer locks. (Label the drawing below.)



_____ _____ _____

(courtesy of Schlage)

Stop for Review

To answer the following questions, circle the letter next to the correct response. Only one correct response is provided for each question.

1. The space between the housing and plug of a cylinder is a _____.
   a. key section
   b. shear line
   c. key cut
   d. follower

2. Arranging the discs or pins in a disc or pin tumbler cylinder to accept a specific **key** is called _____.
   a. master keying
   b. shimming
   c. keying
   d. picking

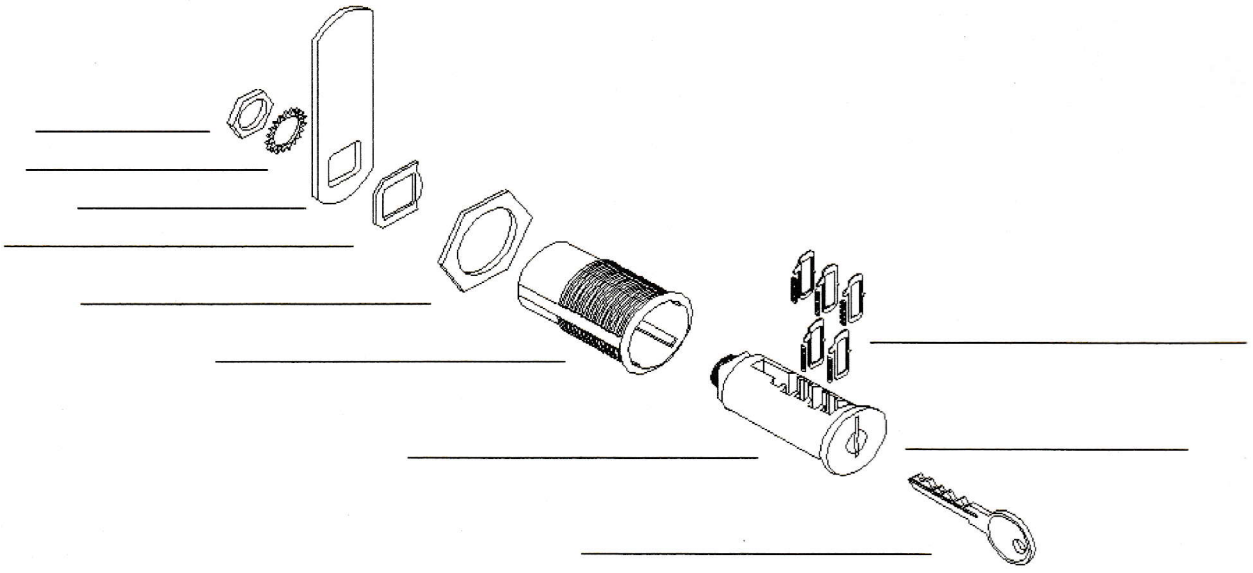
3. Arranging the discs or pins in a disc or pin tumbler cylinder to accept specific **keys** is called _____.
   a. master keying
   b. impressioning
   c. keying
   d. shimming

4. A key that operates all of the locks in a series is a _____.
   a. master key
   b. change key
   c. cylinder key
   d. skeleton key

5. A key that usually operates only one of the locks in a series is a _____.
   a. skeleton key
   b. master key
   c. cylinder key
   d. change key

6. The combined length of the bottom pin and the driver (top) pin is the _____.
   a. combination
   b. key cut
   c. pin stack
   d. shear line

7. Label the parts of the disc tumbler cylinder pictured below.



To answer the following questions about disc tumblers, circle the letter next to the correct response. Only one correct response is provided for each question.

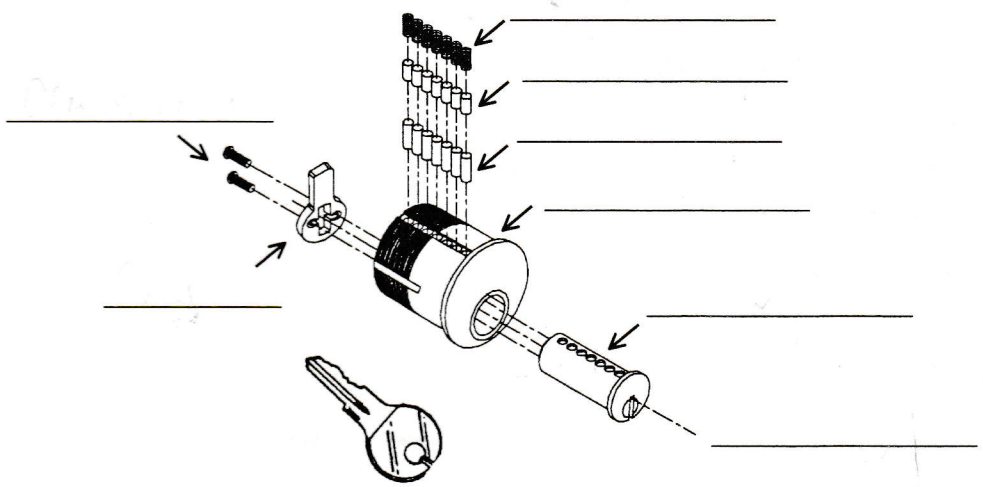
8. The _____ holds the lock onto the door or drawer.
   a. cam or tailpiece
   b. shell nut
   c. shell or housing
   d. nut and lock washer

9. The _____ block the shear line when locked and lift up to the shear line when the proper key is inserted.
   a. disc tumblers
   b. springs
   c. nut and lock washer
   d. cam and cam stop

10. The _____ push the disc tumbler cylinder into the locked position.
    a. cam and cam stop
    b. pins
    c. nut and lock washer
    d. springs

11. When a disc tumbler cylinder is sticking and the key pulls out in any direction, you should _____.
    a. file the plug
    b. replace the cylinder and/or the key
    c. spray the lock with a good lubricant and run a lock pick or cut key in and out of the cylinder
    d. insert a piece of metal into the lock to clean it

12. If the disc is preventing the barrel in a disc tumbler cylinder from turning, you should clean the keyway by _____.
    a. inserting a piece of metal into the lock and working the debris out
    b. disassembling the cylinder and filing the plug
    c. spraying the lock with a good lubricant and running a lock pick or cut key in and out of the cylinder
    d. pushing the key in and out of the keyway until the debris falls out
13. _____ will NOT cause a bent disc tumbler.
    a. Inserting a piece of metal into the lock to remove debris
    b. Spraying the lock with a good lubricant and running a lock pick or cut key in and out of the cylinder
    c. Inserting the correct key into the keyway and forcing it too far
    d. Inserting the wrong key into the keyway and trying to force the lock to turn
14. Label the parts of the pin tumbler cylinder pictured below.



(courtesy of Ilco Unican)

To answer the following questions about pin tumbler cylinders, circle the letter next to the correct response. Only one correct response is provided for each question.

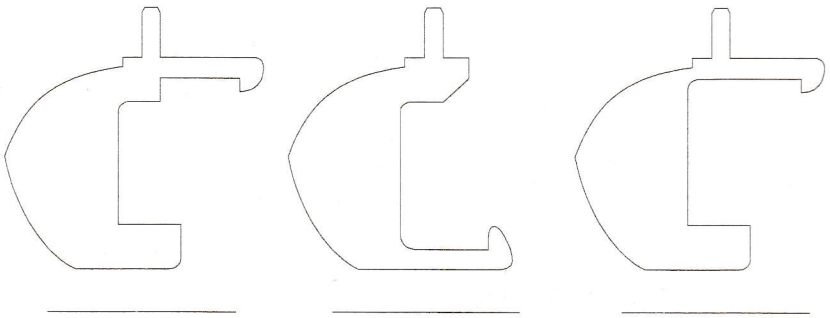
15. The _____ engages the locking mechanism on a mortise cylinder when the plug is turned.
    a. housing
    b. upper pin chamber
    c. driver cam
    d. lower pin chamber
16. The _____ are pushed down into the plug and prevent the plug from turning.
    a. driver (top) pins
    b. cylinder springs
    c. bottom pins
    d. retaining pins

17. The _____ are lifted up to the shear line by the key.
    a. driver (top) pins
    b. cylinder springs
    c. bottom pins
    d. retaining pins

18. If the plug in a pin tumbler cylinder has become oblong, a likely cause is _____.
    a. heavy use
    b. loose screws on the back of the cylinder
    c. a filed plug
    d. using the key as a door pull

19. Filing the plug does NOT _____.
    a. cause the plug to rotate more smoothly
    b. cause the key to stick
    c. allow a master pin to get stuck between the plug and the shell
    d. allow the shear line to become so wide that incorrect keys turn the cylinder

20. Label the drawing below.



_____ _____ _____

(courtesy of Schlage)